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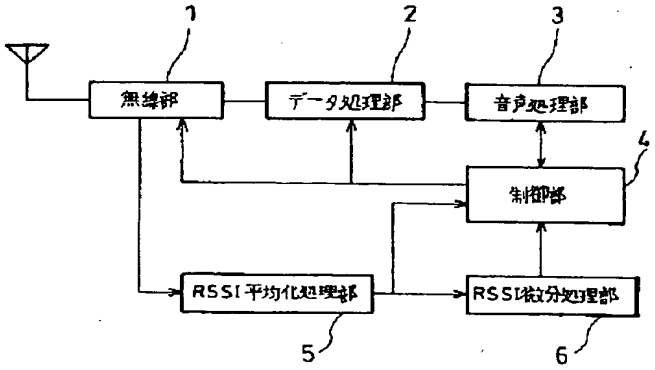
(54)【発明の名称】移動無線端末

(57)【要約】

【課題】　回線が切断された時点での切断状況に応じて回線の再接続動作の試行時間間隔を設定することで、電池の消耗が少なく、しかも回線の回復を迅速に行うことができるような移動無線端末を提供する。

【解決手段】　受信信号の強度を定期的に平均化処理するＲＳＳＩ平均化処理部５と、平均化処理された受信信号強度の時間的な変化である微分値を算出するＲＳＳＩ微分処理部６と、端末全体を制御する制御部４とを有する。制御部４は、回線が切断された時点で、受信信号強度の微分値の絶対値が所定値以上のときには、回線再接続の試行時間間隔が短くなるように、また、上記受信信号強度の微分値の絶対値が所定値よりも小さいときには、回線再接続の試行時間間隔が長くなるように試行時間間隔を制御する。



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【特許請求の範囲】

【請求項１】無線基地局と無線移動通信を行い、通信回線が切断された時に回線の再接続を所定の試行時間間隔で行う移動無線端末において、

上記回線の再接続の試行時間間隔を、回線の切断直前の受信信号強度に応じて設定することを特徴とする移動無線端末。

【請求項２】無線基地局と無線移動通信を行い、通信回線が切断された時に回線の再接続を所定の試行時間間隔で行う移動無線端末において、

上記無線基地局との間で信号を送受信する無線部と、

無線部で受信した信号の強度を定期的に平均化処理する信号強度平均化処理部と、

平均化処理された受信信号強度の時間的な変化率を示す微分値を算出する信号強度微分処理部と、

回線が切断された時点で、上記受信信号強度の微分値の絶対値が所定値以上のときには、回線再接続の試行時間間隔が短くなるように、また、上記受信信号強度の微分値の絶対値が所定値よりも小さいときには、回線再接続の試行時間間隔が長くなるように試行時間間隔を制御する制御部とを備えていることを特徴とする移動無線端末。

【請求項３】上記制御部は、回線の再接続の試行時間間隔を、上記受信信号強度の微分値の大きさに反比例するように制御することを特徴とする請求項２記載の移動無線端末。

【請求項４】上記制御部は、回線切断時点の平均化処理された受信信号強度の平均値が上記無線部における受信感度値よりも小さければ、回線の再接続の試行時間間隔を、予め設定された回線再接続のための試行時間間隔の最大値に設定することを特徴とする請求項２記載の移動無線端末。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、セルラー電話等の移動通信システムにおける移動無線端末に関し、特に、回線が切断された場合の再接続を自動的に行う機能を有する移動無線端末に関するものである。

【０００２】

【従来の技術】従来より、セルラー電話等の移動通信システムでは、複数の無線基地局から構成される通信可能なサービス圏内を移動無線端末が移動して通信を行うようになっている。このような移動通信システムでは、無線チャンネルの受信信号強度が低下するなどして、通信回線の接続状況が悪化した場合、回線が切断される。このように回線接続途中に、回線が切断された場合、回線を再接続するために、自動的に再接続動作が行われる。

【０００３】一般的に、回線接続途中で回線が切断され、自動的に回線の再接続を試行する場合、回線を速やかに回復させるために、再接続動作の試行時間間隔は短く設定されている。

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【０００４】

【発明が解決しようとする課題】ところで、上記のように再接続動作の試行時間間隔が短く設定されている場合、移動無線端末が、無線基地局のサービス圏外に移動して回線が切断された場合のように、回線の接続される見込みの低い状況では、無駄な再接続動作の試行回数が多くなり、急速に移動無線端末の電池を消耗するという問題が生じる。

【０００５】一方、再接続動作の試行時間間隔が長く設定されている場合、前記のような電池の消耗を低減することができるが、移動無線端末が基地局のサービス圏内にあるにも関わらず、トンネルやビルの影に入る等して一時的に回線が切断された場合、即ち回線の接続される見込みの高い状況では、回線の回復までの再接続動作の試行回数が少なくて済むが、一回の再接続の試行時間間隔が長いので、回線の回復に時間がかかるという問題が生じる。

【０００６】本発明は、上記の問題点を解決するためになされたもので、その目的は、回線が切断された状況を推定し、切断状況に応じて回線の再接続動作の試行時間間隔を設定することで、電池の消耗が少なく、しかも回線の回復を迅速に行うことができるような移動無線端末を提供することにある。

【０００７】

【課題を解決するための手段】請求項１の移動無線端末は、上記の課題を解決するために、無線基地局と無線移動通信を行い、通信回線が切断された時に回線の再接続を所定の試行時間間隔で行う移動無線端末において、上記回線の再接続の試行時間間隔を、回線の切断直前の受信信号強度に応じて設定することを特徴としている。

【０００８】上記の構成によれば、例えば回線の切断直前の受信信号強度が所定値以上であれば、無線基地局のサービス圏内で一時的に切断されたと判断し、再接続の試行時間間隔を所定値よりも短くすることで、回線の回復見込みの高い状況での回線回復を迅速に行うことができる。また、回線直前の受信強度が所定値よりも小さければ、移動無線端末が無線基地局のサービス圏外に移動して回線が切断されたと判断し、再接続の試行時間間隔を所定値以上に長くすることで、回線の回復見込みの低い状況での再接続動作を繰り返すことによる電池の消耗を少なくすることができる。

【０００９】請求項２の移動無線端末は、上記の課題を解決するために、無線基地局と無線移動通信を行い、通信回線が切断された時に回線の再接続を所定の試行時間間隔で行う移動無線端末において、上記無線基地局との間で信号を送受信する無線部と、無線部で受信した信号の強度を定期的に平均化処理する信号強度平均化処理部と、平均化処理された受信信号強度の時間的な変化率を示す微分値を算出する信号強度微分処理部と、回線が切

断された時点で、上記受信信号強度の微分値の絶対値が所定値以上のときには、回線再接続の試行時間間隔が短くなるように、また、上記受信信号強度の微分値の絶対値が所定値よりも小さいときには、回線再接続の試行時間間隔が長くなるように試行時間間隔を制御する制御部とを備えていることを特徴としている。

【００１０】上記の構成によれば、回線が切断された時点で、制御部によって、回線切断直前の信号強度微分処理部の微分値に基づいて回線の切断状況が推定することができ、この推定状況に応じて回線の再接続の試行時間間隔を調整し、電池の消耗の低減を図りつつ、回線の回復を迅速に行うことができる。

【００１１】即ち、受信信号強度の微分値が正数あるいは絶対値が所定値よりも小さいときには、受信信号強度がゆるやかに変化していたことを示しており、サービス圏外への移動が推測されるので、再接続の試行時間間隔を長く設定することによって電池の消耗の低減を図ることができる。また、受信信号強度の微分値が、負数あるいは絶対値が所定値以上のときには、受信信号強度が急速に変化したことを示しており、サービス圏内でトンネルの通過等の一時的なシャドーイングである可能性が高いと推測されるので、回線再接続の試行時間間隔を短く設定することによってシャドーイングの解消後の速やかな回線の回復を図ることができる。

【００１２】請求項３の移動無線端末は、上記の課題を解決するために、請求項２の構成に加えて、制御部は、回線の再接続の試行時間間隔を、上記受信信号強度の微分値の大きさに反比例するように制御することを特徴としている。

【００１３】上記の構成によれば、請求項２の作用に加えて、回線の切断直前の回線切断状況を推定する微分値に対応した試行時間間隔で回線の再接続動作を行うことができるので、回線の回復が回線の切断時の状況に応じて適切に行われる。よって、回線の回復の見込みの低い状況での無駄な回線の再接続動作を低減することで、移動無線端末の電池の消耗を低減させると共に、回線の回復の見込みの高い状況での回線の回復を迅速に行うことができる。

【００１４】請求項４の移動無線端末は、上記の課題を解決するために、請求項２の構成に加えて、制御部は、回線切断時点の平均化処理された受信信号強度の平均値が上記無線部における受信感度値よりも小さければ、回線の再接続の試行時間間隔を、予め設定された回線再接続のための試行時間間隔の最大値に設定することを特徴としている。

【００１５】上記の構成によれば、請求項２の作用に加えて、無線基地局のサービス圏の周縁部のような受信信号強度が不安定な場合には、回線の再接続動作の試行時間間隔を設定値の最大にすることで、不安定な受信信号強度の状態での断続的な回線の切断に伴う不要な回線の再接続動作の回数を低減することができるので、移動無線端末の電池の消耗を低減させることができる。

【００１６】

【発明の実施の形態】本発明の実施の一形態について図１に基づいて説明すれば、以下の通りである。

【００１７】本実施の形態にかかる移動無線システムは、無線回線のサービス圏を形成する複数の無線基地局と、これら無線基地局と無線移動通信を行う移動無線端末とからなる。

【００１８】上記移動無線端末は、図１に示すように、図示しない無線基地局との間で電波の送受信を行う無線部１、送受信信号に対して所定の処理を行うデータ処理部２、マイクロホン（送話部）およびイヤースピーカ（受話部）を含む音声処理部３、移動無線端末全体の制御を行う制御部４、受信信号強度（以下、ＲＳＳＩと称する）を平均化処理するＲＳＳＩ平均化処理部５、平均化されたＲＳＳＩを微分処理するＲＳＳＩ微分処理部６からなっている。

【００１９】データ処理部２では、移動無線端末の作動中、無線部１を介して入力される無線基地局からの信号を音声データと制御データとに分離し、音声データを音声処理部３に出力する一方、制御データを制御部４に出力するようになっている。一方、音声処理部３からの音声データを無線基地局に送信する場合には、音声データと制御部４からの制御データとを統合して、無線部１を介して無線基地局に出力するようになっている。

【００２０】音声処理部３では、イヤースピーカから入力された音声データを受信音声として再生する一方、マイクロホンから入力された音声を音声データに変換し、データ処理部２に出力するようになっている。

【００２１】ＲＳＳＩ平均化処理部５では、一定時間毎（例えば２０ｍｓｅｃ毎）に無線部１の受信信号強度データを取込み平均化処理を行い、過去Ｎ個の平均化されたＲＳＳＩ$_N$ サンプルデータ（但し、Ｎは１以上の整数）を保持するようになっている。そして、平均化処理されたＲＳＳＩ$_N$ サンプルデータを、制御部４およびＲＳＳＩ微分処理部６に出力するようになっている。

【００２２】ＲＳＳＩ微分処理部６では、ＲＳＳＩ平均化処理部５のＮ個のサンプルデータから時間毎の変化率を計算して、ＲＳＳＩの微分値を算出するようになっている。例えば、最新のＮ番目のサンプルに対するＲＳＳＩの微分値ＲＳＳＩdif$_N$ は、ＲＳＳＩ$_{N-1}$ －ＲＳＳＩ$_N$ で求めることができる。そして、算出された微分値ＲＳＳＩdif を、ＲＳＳＩ微分処理部６内で記憶すると共に、制御部４に出力するようになっている。

【００２３】制御部４は、データ処理部２からの制御データに基づいて回線制御を行うと共に、ＲＳＳＩ平均化処理部５からの平均化されたＲＳＳＩ$_N$ サンプルデータおよびＲＳＳＩ微分処理部６からの微分値ＲＳＳＩdif に基づいて、回線が切断されたときの再接続動作の制御

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を行うようになっている。即ち、制御部４は、回線接続途中で回線が切断されたときに、自動的に回線の再接続動作を試行する機能を有している。

【００２４】つまり、制御部４は、何らかの要因でＲＳＳＩレベルが低下し、通信回線の接続を維持できなくなった場合、通信回線の切断処理を行うと共に、ＲＳＳＩ微分処理部６内に記憶されている回線切断直前のＲＳＳＩ微分値を参照し、このＲＳＳＩ微分値から回線の切断時の状況を推定し、このＲＳＳＩ微分値から推定される回線の切断時の状況から再接続の試行時間間隔を設定し、再接続動作を行うようになっている。

【００２５】一般に、回線接続途中で回線が切断される理由として考えられるのは、移動無線端末が無線基地局により形成されているサービス圏内の外に移動した場合、サービス圏内であっても移動無線端末がシャドーイングとなる場所、即ち移動無線端末がトンネルを通過したり、ビルの影に移動したりして移動無線端末が一時的に電波の届かない場所に移動した場合とがある。

【００２６】したがって、回線が切断されたとき、移動無線端末がサービス圏外に移動した場合、回線の回復の見込みが低く、再接続動作を試行しても無駄な場合が多い。一方、移動無線端末がサービス圏内でシャドーイングとなる場所に移動した場合、回線の回復の見込みが高く、再接続動作を試行すればすぐに回線が回復する場合が多い。よって、移動無線端末による回線の再接続動作による試行時間は、回線の切断された状況に基づいて設定すれば良いことが分かる。

【００２７】ここで、回線の切断時の状況を推定し、この推定した状況に基づいて回線の再接続動作を試行する移動無線端末の制御部４における制御について以下に説明する。

【００２８】回線の切断が発生した時点のＲＳＳＩの微分値を前述のＲＳＳＩ$difN_N$とすると、ＲＳＳＩ$difN_N$が負の値のときは、ＲＳＳＩが低下して回線が切断されたことを示し、更に負の値が大きければ、切断直前に急激にＲＳＳＩレベルが低下したことを示し、回線切断は一時的なシャドーイングによって回線の切断が起こったと推定される。

【００２９】一方、上記ＲＳＳＩ$difN_N$の絶対値が比較的小さく、更にＲＳＳＩ平均化処理部５におけるＲＳＳＩサンプルデータの値が所定値よりも小さい場合には、ＲＳＳＩが徐々に低下していることを示し、移動無線端末が無線基地局のサービス圏外に移動したことにより回線の切断が起こったと推定される。

【００３０】それ故、制御部４は、回線の切断がシャドーイングによる場合、回線の回復が直ぐに行われるものと判断し、回線の再接続の試行時間間隔を比較的短く設定するようになっている。これにより、回線が切断されたとき、短い試行時間間隔で回線の再接続動作を行うことで、迅速に回線の回復を行うことができる。

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【００３１】また、制御部４は、回線の切断が移動無線端末が無線基地局のサービス圏外への移動による場合、回線の回復が見込み難いと判断し、回線の再接続の試行時間間隔を比較的長く設定するようになっている。これにより、回線が切断されたとき、長い試行時間間隔で回線の再接続動作を行うことで、無駄な回線接続動作を低減することができるので、移動無線端末の電池の消耗を低減することができる。

【００３２】尚、上記ＲＳＳＩ平均化処理部５での受信信号強度のサンプリング間隔は、上記２０ｍｓｅｃ毎に限定するものではなく、数１０ｍｓｅｃ間隔であれば良い。また、ＲＳＳＩの平均化を行う回数は、特に限定するものではないが、数回が望ましい。

【００３３】また、回線の再接続の試行時間間隔は、回線の回復が早くなると見込まれる場合には回線の回復を早くし得る値、回線の回復が遅くなると見込まれる場合には電池の消耗を低減させる値に設定すれば良く、限定するものではない。

【００３４】例えば、試行時間間隔の設定方法としては、ＲＳＳＩ微分処理部６の回線切断直前の微分値であるＲＳＳＩ$difN_N$の大きさに反比例した大きさで試行時間間隔を設定する方法が考えられる。この場合、回線の切断直前の回線切断状況を推定する微分値ＲＳＳＩ$difN_N$に対応した試行時間間隔で回線の再接続動作を行うことができるので、回線の回復が回線の切断時の状況に応じて適切に行われる。よって、回線の回復の見込みの低い状況での無駄な回線の再接続動作を低減することで、移動無線端末の電池の消耗を低減させると共に、回線の回復の見込みの高い状況での回線の回復を迅速に行うことができる。

【００３５】上記の試行時間間隔の設定の他に、予め異なるレベルの複数のスレショルドレベルと、これら各スレショルドレベルに対応した時間間隔とを記憶しておき、ＲＳＳＩ微分処理部６の回線切断直前の微分値であるＲＳＳＩ$difN_N$と、上記の各スレショルドレベルとを比較し、その差の絶対値が所定値以内となるスレショルドレベルに対応した時間間隔を回線の再接続動作の試行時間間隔とする方法がある。

【００３６】また、回線切断時のＲＳＳＩの平均レベルが、移動無線端末の無線部１における受信感度に相当する値（スレショルドレベル）よりも低い場合には、ＲＳＳＩ微分処理部６による微分値に基づいた試行時間間隔を採用せず、移動無線端末が設定し得る最大の時間間隔を試行時間間隔として設定する方法もある。この場合、無線基地局のサービス圏の周縁部のような受信信号強度が不安定な場合には、回線の再接続動作の試行時間間隔を設定値の最大にすることで、不安定な受信信号強度の状態での断続的な回線の切断に伴う不要な回線の再接続動作の回数を低減することができるので、移動無線端末の電池の消耗を低減させることができる。

【００３７】

【発明の効果】請求項１の発明の移動無線端末は、以上のように、無線基地局と通信を行い、回線が切断された時に回線の再接続を所定の試行時間間隔で行う移動無線端末において、上記回線の再接続の試行時間間隔を、回線の切断直前の受信信号強度に応じて調整する構成である。

【００３８】それゆえ、例えば回線の切断直前の受信信号強度が所定値以上であれば、無線基地局のサービス圏内で一時的に切断されたと判断し、再接続の試行時間間隔を所定値よりも短くすることで、回線の回復見込みの高い状況での回線回復を迅速に行うことができる。また、回線直前の受信強度が所定値よりも小さければ、移動無線端末が無線基地局のサービス圏外に移動して回線が切断されたと判断し、再接続の試行時間間隔を所定値以上に長くすることで、回線の回復見込みの低い状況での再接続動作を繰り返すことによる電池の消耗を少なくすることができるという効果を奏する。

【００３９】請求項２の発明の移動無線端末は、以上のように、無線基地局と通信を行い、回線が切断されたときに回線の再接続を所定の試行時間間隔で行う移動無線端末において、通信に伴う信号を送受信する無線部と、無線部で受信した信号の強度を定期的に平均化処理する信号強度平均化処理部と、平均化処理された受信信号強度の時間的な変化である微分値を算出する信号強度微分処理部と、回線が切断された時点で、受信信号強度の微分値が、負数あるいは絶対値が所定値以上のときには、回線再接続の試行時間間隔が短くなるように、また、上記受信強度の微分値が、正数あるいは絶対値が所定値よりも小さいときには、回線再接続の試行時間間隔が長くなるように試行時間間隔を制御する制御部とを備えている構成である。

【００４０】それゆえ、回線が切断された時点で、制御部によって、回線切断直前の信号強度微分処理部の微分値に基づいて回線の切断状況が推定することができ、この推定状況に応じて回線の再接続の試行時間間隔を調整し、電池の消耗の低減を図りつつ、回線の回復を迅速に行うことができるという効果を奏する。

【００４１】請求項３の発明の移動無線端末は、以上のように、請求項２の構成に加え、制御部が、回線の再接続の試行時間間隔を、上記受信信号強度の微分値の大きさに反比例するように制御する構成である。

【００４２】それゆえ、請求項２の構成による効果に加えて、回線の切断直前の回線切断状況を推定する微分値に対応した試行時間間隔で回線の再接続動作を行うことができるので、回線の回復が回線の切断時の状況に応じて適切に行われる。

【００４３】よって、回線の回復の見込みの低い状況での無駄な回線の再接続動作を低減することで、移動無線端末の電池の消耗を低減させると共に、回線の回復の見込みの高い状況での回線の回復を迅速に行うことができるという効果を奏する。

【００４４】請求項４の発明の移動無線端末は、以上のように、請求項２の構成に加え、制御部は、回線切断時点の平均化処理された受信信号強度の平均値が上記無線部における受信感度値よりも小さければ、回線の再接続の試行時間間隔を、予め設定された回線再接続のための試行時間間隔の最大値に設定する構成である。

【００４５】それゆえ、請求項２の構成による効果に加えて、無線基地局のサービス圏の周縁部のような受信信号強度が不安定な場合には、回線の再接続動作の試行時間間隔を設定値の最大にすることで、不安定な受信信号強度の状態での断続的な回線の切断に伴う不要な回線の再接続動作の回数を低減することができるので、移動無線端末の電池の消耗を低減させることができるという効果を奏する。

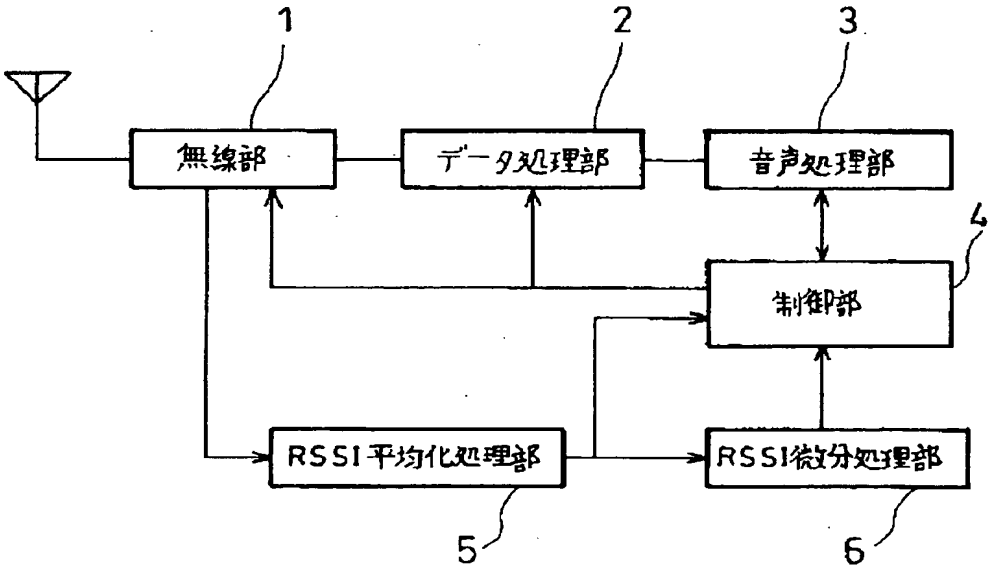
【図面の簡単な説明】

【図１】本発明の一実施の形態に係る移動無線端末の概略ブロック図である。

【符号の説明】

１　無線部
４　制御部
５　ＲＳＳＩ平均化処理部（受信信号強度平均化処理部）
６　ＲＳＳＩ微分処理部（受信信号強度微分処理部）

【図1】



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INVENTOR(S)	Kenkichi SUZUKI

ABSTRACT

[Problem] To offer a mobile radio terminal wherein the time interval for attempting reconnection operations is set according to the severance conditions at the time that a channel is severed, thus making the battery consumption low and enabling the channel to be recovered quickly.

[Solution] The invention comprises an RSSI averaging processing portion 5 for periodically averaging the intensity of a received signal, an RSSI derivative processing portion 6 for calculating derivative values which are the temporal changes in the averaged received signal intensities and a control portion 4 for controlling the terminal overall. The control portion 4 controls the time intervals between attempts such as to shorten the time interval between attempts at reconnection to the channel when the absolute value of the derivative value of the received signal intensity is at least a predetermined value, and to lengthen the time interval between attempts at reconnection to the channel when the absolute value of the derivative value of the received signal intensity is less than a predetermined value.

CLAIMS

1. A mobile radio terminal for performing radio mobile communications with a radio base station, and when the communication channel is severed, performing reconnection to the channel at predetermined time intervals between attempts, the mobile radio terminal being characterized in that said time intervals between channel reconnection attempts are set according to a received signal intensity immediately prior to severance of the channel.

2. A mobile radio terminal for performing radio mobile communications with a radio base station, and when the communication channel is severed, performing reconnection to the channel at predetermined time intervals between attempts, the mobile radio terminal being characterized by comprising:

a radio portion for transmitting and receiving signals between said radio base station;

a signal intensity averaging processing portion for periodically averaging the intensity of the signals received by the radio portion;

a signal intensity derivative processing portion for calculating a derivative value which indicates the rate of change of the averaged received signal intensity over time; and

a control portion for controlling time intervals between attempts such as to shorten the time interval between channel reconnection attempts when an absolute value of the derivative value of said received signal intensity is at least a predetermined value at the time the channel is severed, and to lengthen the time interval between channel reconnection attempts when the absolute value of the derivative value of said received signal intensity is less than the predetermined value.

3. A mobile radio terminal as recited in claim 2, characterized in that said control portion controls the time intervals between channel reconnection attempts such as to be inverse proportional to the magnitude of the derivative value of said received signal intensity.

4. A mobile radio terminal as recited in claim 2, characterized in that said control portion sets the time intervals between channel reconnection attempts to a preset maximum value of time intervals between channel reconnection attempts if the average value of average received signal intensities at the time of channel severance is smaller than the reception sensitivity value in said radio portion.

DETAILED DESCRIPTION OF THE INVENTION

Field of Industrial Application

The present invention relates to a mobile radio terminal in a mobile communication system such as a cellular telephone, and particularly relates to a mobile radio terminal having a function of automatically performing reconnection when the channel is severed.

Prior Art

In conventional mobile communication systems such as cellular telephones and the like, communications are performed by mobile radio terminals moving in service areas composed of a plurality of radio base stations wherein communications are possible. In this type of mobile communication system, when the connection conditions of communication channels become bad due to reductions in received signal intensity of the radio channels, the channel can be severed. In this way, when channels are severed during channel connection, an automatic reconnection operation is performed in order to reconnect the channel.

In general, when a channel has been severed during channel connection and channel reconnection attempts are automatically made, the time intervals between reconnection operation attempts are set to be shorter in order to make the recovery of the channel quicker.

Problems to be Solved by the Invention

If the time interval between reconnection operation attempts is set short as mentioned above, then in situations where the probability of connection to the channel is low such as when the channel is severed because the mobile radio terminal has moved outside the service area of a radio base station, there is a large number of wasted reconnection operation attempts, so that the batteries of the mobile radio terminal are rapidly consumed.

On the other hand, if the time interval between reconnection operation attempts is set

long, battery consumption such as mentioned above can be reduced, but when the channel has been temporarily severed due to entry into a tunnel or the shadow of a building while the mobile radio terminal is still in the service area of a base station, i.e. when there is a high probability of channel connection, the number of reconnection operation attempts until channel recovery will be reduced, but since the time interval until a single reconnection attempt is long, time is required in order to recover the channel.

The present invention has been achieved in order to resolve the above-described problems, and has the purpose of offering a mobile radio terminal which deduces the conditions under which a channel was severed and sets the time intervals between channel reconnection operation attempts according to the severance conditions, thereby enabling the battery consumption to be reduced and enabling the channel to be recovered quickly.

Means for Solving the Problems

In order to resolve the above-mentioned problems, the mobile radio terminal according to claim 1 is a mobile radio terminal for performing radio mobile communications with a radio base station, and when the communication channel is severed, performing reconnection to the channel at predetermined time intervals between attempts, characterized in that the time intervals between channel reconnection attempts are set according to a received signal intensity immediately prior to severance of the channel.

According to the above-described structure, if for example the received signal intensity immediately prior to channel severance is at least a predetermined value, then it is judged to have been temporarily severed inside the service area of a radio base station, so that by making the time interval between reconnection attempts shorter than a predetermined value, it is possible to quickly perform channel recovery under conditions where there is a high probability of channel recovery. Additionally, if the reception intensity immediately prior to channel severance is smaller than the predetermined value, then it is judged that the channel has been severed due to the mobile radio terminal having moved outside the service area of the radio base station, so that by making the time interval between reconnection attempts longer than a predetermined value, it is possible to reduce the battery consumption caused by repeated reconnection operations under conditions with a low probability of channel recovery.

In order to resolve the above-mentioned problems, a mobile radio terminal of claim 2 is a mobile radio terminal for performing radio mobile communications with a radio base station, and when the communication channel is severed, performing reconnection to the channel at predetermined time intervals between attempts, characterized by comprising a radio portion for transmitting and receiving signals between said radio base station; a signal intensity averaging processing portion for periodically averaging the intensity of the signals received by the radio portion; a signal intensity derivative processing portion for calculating a derivative value which indicates the rate of change

of the averaged received signal intensity over time; and a control portion for controlling time intervals between attempts such as to shorten the time interval between channel reconnection attempts when an absolute value of the derivative value of said received signal intensity is at least a predetermined value at the time the channel is severed, and to lengthen the time interval between channel reconnection attempts when the absolute value of the derivative value of said received signal intensity is less than the predetermined value.

According to this structure, at the time that a channel is severed, the control portion can deduce the channel severance conditions based on derivative values of the signal intensity derivative processing portion immediately prior to channel severance, and the time interval between channel reconnection attempts can be adjusted according to these deduced conditions, thereby enabling the channel to be recovered quickly while ensuring a reduction in battery consumption.

That is, when the derivative value of the received signal intensity is a positive number or has an absolute value smaller than a predetermined value, this indicates that the received signal intensity changed gradually, thus implying a movement outside the service area, so that reductions in battery consumption can be ensured by setting the time interval between reconnection attempts to be long. Additionally, when the derivative value of the received signal intensity is a negative number or has an absolute value which is at least a predetermined value, this indicates a rapid change in the received signal intensity, which indicates a high probability of temporary shadowing by passage through a tunnel or the like in the service area, so that a swift channel recovery after the elimination of the shadowing can be ensured by setting the time interval between channel reconnection attempts short.

In order to resolve the above-mentioned problems, the mobile radio terminal of claim 3, in addition to the structure of claim 2, is characterized in that the control portion controls the time intervals between channel reconnection attempts such as to be inverse proportional to the magnitude of the derivative value of said received signal intensity.

According to the above-described structure, it is possible, in addition to the functions of claim 2, to perform channel reconnection operations with time intervals between attempts which correspond to the derivative values which indicate the channel severance conditions immediately prior to channel severance, thus enabling channel recovery to be performed appropriately in accordance with the conditions at the time of channel severance. Consequently, it is possible to reduce battery consumption of the mobile radio terminal by reducing needless channel reconnection operations in situations where the possibility of channel recovery is low, and also to rapidly achieve channel recovery in situations where the possibility of channel recovery is high.

In order to resolve the above-mentioned problems, the mobile radio terminal of claim 4, in addition to the structure of claim 2, is characterized in that the control portion sets the time intervals between channel reconnection attempts to a preset maximum value of

time intervals between channel reconnection attempts if the average value of average received signal intensities at the time of channel severance is smaller than the reception sensitivity value in said radio portion.

According to the above-described structure, in addition to the functions of claim 2, the time interval between channel reconnection operation attempts is made a maximum of preset values for the time interval between channel reconnection operation attempts when the received signal intensity is unstable such as in peripheral portions of the service area of a radio base station, thereby enabling a reduction in the number of needless channel reconnection operations which accompany intermittent channel severance in a state of unstable received signal intensities, thus reducing battery consumption of the mobile radio terminal.

Embodiments of the Invention

An embodiment of the present invention can be explained as follows with reference to Fig. 1.

The mobile radio system according to the present embodiment is composed of a plurality of radio base stations forming radio channel service areas, and a mobile radio terminal which performs radio mobile communications with these radio base stations.

As shown in Fig. 1, the above-described mobile radio terminal is composed of a radio portion 1 for transmitting and receiving radio waves between a radio base station which is not shown, a data processing portion 2 for performing a predetermined process on the transmitted and received signals, a speech processing portion 3 containing a microphone (call transmitting portion) and an ear speaker (call receiving portion), a control portion 4 for performing control of the mobile radio terminal overall, an RSSI averaging processing portion 5 for averaging a received signal intensity (hereinafter abbreviated as RSSI) and an RSSI derivative processing portion 6 for taking the derivative of the averaged RSSI.

In the data processing portion 2, the signals from the radio base station which are inputted via the radio portion 1 during activation of the mobile radio terminal are separated into speech data and control data, and the speech data are outputted to the speech processing portion 3, while the control data are outputted to the control portion 4. On the other hand, when the speech data from the speech processing portion 3 is transmitted to the radio base station, the speech data is combined with the control data from the control portion 4, and outputted via the radio portion 1 to the radio base station.

In the speech processing portion 3, the speech data inputted from the ear speaker is reproduced as received speech, while the speech inputted from the microphone is converted to speech data and outputted to the data processing portion 2.

In the RSSI averaging processing portion 5, the received signal intensity data of the radio portion 1 is inputted and averaged every standard period of time (e.g. 20 msec), and the last N averaged $RSSI_N$ sample data are stored (N being an integer greater than or equal to 1). Then, the averaged $RSSI_N$ sample data are outputted to the control portion 4 and RSSI derivative processing portion 6.

In the RSSI derivative processing portion 6, the rate of change over time is calculated from N sample data of the RSSI averaging processing portion 5, and the derivative value of RSSI is calculated. For example, the derivative value $RSSIdifN_N$ of RSSI with respect to the last N samples can be determined as $RSSI_{N-1} - RSSI_N$. Then, the calculated derivative value RSSIdif is stored in the RSSI derivative processing portion 6 and outputted to the control portion 4.

The control portion 4 performs channel control based on control data from the data processing portion 2 and controls the reconnection operation when the channel is severed based on the averaged $RSSI_N$ sample data from the RSSI averaging processing portion 5 and derivative values RSSIdif from the RSSI derivative processing portion 6. That is, the control portion 4 has the function of automatically attempting a channel reconnection operation when the channel is severed during channel connection.

That is, the control portion 4 performs a communication channel severing process when the RSSI level falls due to some factor and the communication channel connection cannot be maintained, refers to the RSSI derivative values from immediately prior to channel severance stored in the RSSI derivative processing portion 6, deduces the condition at the time of channel severance from this RSSI derivative value, and sets a time interval for reconnection attempts from the conditions at the time of channel severance deduced from this RSSI derivative value, thus to perform the reconnection operation.

Generally speaking, the reasons for a channel being severed during channel connection include cases where the mobile radio terminal has moved outside the service area formed by the radio base station, and cases where the mobile radio terminal, while still inside the service area, is in a place where the mobile radio terminal is shadowed, i.e. passing through a tunnel or moved into the shadow of a building, where radio waves temporarily cannot reach.

Therefore, when the channel is severed, if the mobile radio terminal has moved outside the service area, the probability that the channel will recover is low, and reconnection operation attempts are often in vain. On the other hand, if the mobile radio terminal has moved to a place where there is shadowing inside the service area, then there is a high probability that the channel will recover, and it is often the case that the channel will immediately recover if a reconnection operation is attempted. Consequently, this shows that the times for attempting channel reconnection operations by means of the mobile radio terminal should be set based on the conditions whereby the channel was severed.

Here, the control in the control portion 4 of the mobile radio terminal which deduces the conditions at the time of channel severance and attempts channel reconnection operations based on these deduced conditions shall be explained below.

When the derivative value of RSSI at the time a channel severance occurred is taken as the above-mentioned $RSSIdifN_N$, if $RSSIdifN_N$ is a negative value, then this indicates that the channel was severed when RSSI was decreasing, and if the negative value is even larger, then this indicates that the RSSI level dropped suddenly immediately prior to severance, from which it can be deduced that the channel severance is such that the channel severance occurred due to temporary shadowing.

On the other hand, if the absolute value of the above-described $RSSIdifN_N$ is small and the RSSI sample data values in the RSSI averaging processing portion 5 are smaller than a predetermined value, then this indicates that the RSSI gradually decreased, from which it can be deduced that the channel severance occurred by the mobile radio terminal moving outside the service area of the radio base station.

Thus, the control portion 4 determines the channel recovery will be able to be performed immediately when the channel severance is due to shadowing, and the time interval between channel reconnection attempts is set to be comparatively short. As a result, when the channel is severed, the channel can be quickly recovered by performing a channel reconnection operation with a short time interval between attempts.

Additionally, when the severance of the channel is due to the mobile radio terminal moving outside the service area of the radio base station, the control portion 4 judges that there is not much possibility of channel recovery, and sets the time interval between channel reconnection attempts to be comparatively long. As a result, by performing channel reconnection operations with a long time interval between attempts when the channel is severed, it is possible to reduce needless channel connection operations, thereby reducing the battery consumption of the mobile radio terminal.

The sampling interval for received signal intensities in the above-mentioned RSSI averaging processing portion 5 is not limited to the above-mentioned 20 msec, and is required only to be an interval of a few tens of milliseconds. Additionally, the number of times RSSI is averaged is not particularly restricted, but a few times is desirable.

Additionally, the time interval between channel reconnection attempts is not restricted as long as it is set to a value such as to be able to make channel recovery faster when it is expected that channel will be able to recover faster, and such as to reduce battery consumption when it is respected that channel recovery will be delayed.

For example, as a method for setting the time interval between attempts, it is possible to consider setting the time interval between attempts such as to be inverse proportional to the magnitude of $RSSIdifN_N$ which is the derivative value immediately prior to channel

severance of the RSSI derivative processing portion 6. In this case, it is possible to perform channel reconnection operations at a time interval between attempts which corresponds to the derivative value $RSSIdifN_N$ from which the channel severance conditions immediately prior to channel severance are deduced, so that channel recovery is performed appropriately in accordance with the conditions at channel severance. Consequently, by reducing unneeded channel reconnection operations under conditions where the possibility of channel recovery is low, it is possible to reduce battery consumption of the mobile radio terminal, while enabling the quick recovery of the channel under conditions where the possibility of channel recovery is high.

Aside from setting the time interval between attempts as described above, there is a method of prestoring a plurality of threshold levels of different levels and time intervals corresponding to these threshold levels, comparing $RSSIdfN_N$ which is the derivative value of the RSSI derivative processing portion 6 immediately prior to channel severance with the above-described threshold levels, and making the time interval between channel reconnection attempts equal to a time interval corresponding to a threshold level where the absolute value of the difference is within a predetermined value.

Additionally, there is a method such that when the average level of RSSI at the time of channel severance is less than a value (threshold level) corresponding to the reception sensitivity in the radio portion 1 of the mobile radio terminal, a time interval between attempts based on the derivative values from the RSSI derivative processing portion 6 is not employed, and the maximum time interval capable of being set by the mobile radio terminal is set as the time interval between attempts. In this case, when the reception signal intensity is unstable such as in peripheral portions of the service area of a radio base station, it is possible to reduce the number of unneeded channel reconnection operations which accompany intermittent channel severance in a situation where the received signal intensity is unstable by maximizing the set value for the time interval between channel reconnection operation attempts, thereby enabling battery consumption in the mobile radio terminal to be reduced.

Effects of the Invention

As described above, the mobile radio terminal of the invention of claim 1 is a mobile radio terminal for performing radio mobile communications with a radio base station, and when the communication channel is severed, performing reconnection to the channel at predetermined time intervals between attempts, having a structure wherein said time intervals between channel reconnection attempts are set according to a received signal intensity immediately prior to severance of the channel.

Consequently, if for example the received signal intensity immediately prior to channel severance is at least a predetermined value, then it is judged to have been temporarily severed inside the service area of a radio base station, so that by making the time

interval between reconnection attempts shorter than a predetermined value, it is possible to quickly perform channel recovery under conditions where there is a high probability of channel recovery. Additionally, if the reception intensity immediately prior to channel severance is smaller than the predetermined value, then it is judged that the channel has been severed due to the mobile radio terminal having moved outside the service area of the radio base station, so that by making the time interval between reconnection attempts longer than a predetermined value, it is possible to reduce the battery consumption caused by repeated reconnection operations under conditions with a low probability of channel recovery.

As described above, the mobile radio terminal of the invention of claim 2 is a mobile radio terminal for performing radio mobile communications with a radio base station, and when the communication channel is severed, performing reconnection to the channel at predetermined time intervals between attempts, with a structure comprising a radio portion for transmitting and receiving signals between said radio base station; a signal intensity averaging processing portion for periodically averaging the intensity of the signals received by the radio portion; a signal intensity derivative processing portion for calculating a derivative value which indicates the rate of change of the averaged received signal intensity over time; and a control portion for controlling time intervals between attempts such as to shorten the time interval between channel reconnection attempts when an absolute value of the derivative value of said received signal intensity is at least a predetermined value at the time the channel is severed, and to lengthen the time interval between channel reconnection attempts when the absolute value of the derivative value of said received signal intensity is less than the predetermined value.

As a consequence, at the time that a channel is severed, the control portion can deduce the channel severance conditions based on derivative values of the signal intensity derivative processing portion immediately prior to channel severance, and the time interval between channel reconnection attempts can be adjusted according to these deduced conditions, thereby enabling the channel to be recovered quickly while ensuring a reduction in battery consumption.

As described above, the mobile radio terminal of the invention of claim 3, in addition to the structure of claim 2, has a structure wherein the control portion controls the time intervals between channel reconnection attempts such as to be inverse proportional to the magnitude of the derivative value of said received signal intensity.

Consequently, it is possible, in addition to the effects of claim 2, to perform channel reconnection operations with time intervals between attempts which correspond to the derivative values which indicate the channel severance conditions immediately prior to channel severance, thus enabling channel recovery to be performed appropriately in accordance with the conditions at the time of channel severance.

Thus, it is possible to reduce battery consumption of the mobile radio terminal by reducing needless channel reconnection operations in situations where the possibility of

channel recovery is low, and also to rapidly achieve channel recovery in situations where the possibility of channel recovery is high.

As described above, the mobile radio terminal of claim 4, in addition to the structure of claim 2, has a structure wherein the control portion sets the time intervals between channel reconnection attempts to a preset maximum value of time intervals between channel reconnection attempts if the average value of average received signal intensities at the time of channel severance is smaller than the reception sensitivity value in said radio portion.

Consequently, in addition to the effects of claim 2, the time interval between channel reconnection operation attempts is made a maximum of preset values for the time interval between channel reconnection operation attempts when the received signal intensity is unstable such as in peripheral portions of the service area of a radio base station, thereby enabling a reduction in the number of needless channel reconnection operations which accompany intermittent channel severance in a state of unstable received signal intensities, thus reducing battery consumption of the mobile radio terminal.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 A schematic block diagram of a mobile radio terminal according to an embodiment of the present invention.

Description of the Reference Numbers

1 radio portion
4 control portion
5 RSSI averaging processing portion
(received signal intensity averaging processing portion)
6 RSSI derivative processing portion
(received signal intensity derivative processing portion)